The fifth annual meeting of the Oklahoma Academy of Science was held at Oklahoma City, Oklahoma, November 26 and 27, 1915. Thirty-five papers, dealing with various phases of biology, physics, chemistry and geology were presented. The address by the retiring president, Mr. Chas. W. Shannon, director of the Oklahoma Geological Survey, dealt with the work of the Oklahoma Academy of Science and its connection with the scientific work of the state. The following officers were elected for the ensuing year:

President, Chas. N. Gould, Oklahoma City.
First Vice-president, L. Chas. Raiford, Stillwater.
Second Vice-president, L. B. Nice, Norman.
Secretary, G. K. Stanton, Enid.
Assistant Secretary, Ethel L. McCafferty, Enid.
Treasurer, H. H. Lane, Norman.
Curator, Fritz Aurin, Norman.

The next meeting of the academy will be held in November, 1916, at the time and place of the meeting of the Oklahoma State Teachers' Association.

The Stanford University Medical School announces the thirty-fourth course of Popular Medical Lectures to be given in Lane Hall on alternate Friday evenings as follows:

January 14. "Medical Research and Its Relation to General Medicine," by Dr. George H. Whipple, director of the Hooper Foundation for Medical Research.

January 28. "The Economic Aspect of Disease," by Murray S. Wildman, Ph.D., professor of economics.

February 11. "Disease Carriers," by Dr. W A. Sawyer, secretary, California State Board of Health.

February 25. "The Relation of Hospitals to the Community," by Dr. George B. Somers.

March 10. "Locomotion in Health and Disease," by Dr. Walter F. Schaller.

March 24. "Mental Hygiene," by Lilien J. Martin, Ph.D., professor of psychology.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of Miss Rose Hollingsworth, of Boston, the Massachusetts Institute of Technology, Radcliffe College, Mount Holyoke College and the Tuskegee Industrial Institute each receive $5,000. Five hundred dollars are bequeathed to the Gray Herbarium, the National Association of Audubon Societies, the Society for the Protection of Native Plants, the American Forestry Association and to the Massachusetts Forestry Association.

A gift of $75,000 has been announced to the Harvard Medical School. This is the balance of the bequest of Morrill Wyman, who established the Morrill Wyman Medical Research Fund, the income of which is to be applied in promoting investigation concerning the origin, results, prevention and treatment of disease.

The executors of the estate of the late Lord Strathcona have notified Queen's University, Kingston, that the $100,000 left to that university is now available and ready to be paid.

A valuable collection of periodicals, monographs and other medical books, consisting of more than 4,000 volumes, has been presented to the Johns Hopkins Hospital by Dr. Howard A. Kelly.

Professor Henry A. Perkins, of the department of physics, is acting president of Trinity College during the absence of President Luther.

DISCUSSION AND CORRESPONDENCE

THE ORIGIN OF THE "NITER SPOTS" IN CERTAIN WESTERN SOILS[1]

In a recent issue of Science, under the above title, Sackett and Isham[1] discussed this important question but conveyed no actual information regarding either the meaning of the term "niter spot" or its origin. They merely select for discussion a single point out of the great mass of available material so that the general scientific reader to whom an appeal is thus made through the columns of Science is left in doubt as to what it is all about. In order to clarify the matter for the average reader, it seems advisable to submit some definite information on the subject in

[1] Sackett and Isham, Science, Vol. XLII., p. 452, October 1, 1915.

order that those who are not familiar with the data in the technical publications may form an intelligent opinion regarding the merits of the several theories proposed regarding the origin of these spots.

The term "niter spots" has recently been applied by Headden[2] to alkali accumulations in certain western soils which develop spots of a dark brown color. Formerly alkali soils were classified as white and black alkali, depending upon the presence or absence of color. The black color of the black alkali spots is due, as shown by Hilgard, to the presence of sodium carbonate, which has a solvent and decomposing action upon the organic matter in the soil. The white alkali consisting largely of the sulphate and chloride of sodium, having no solvent and decomposing action on the organic matter, does not produce any color. There is also an intermediate condition where the color of the alkali spot is a dark or light brown. In these so-called "niter spots" there are two main points which differentiate them from either the white or black alkali soils: (1) the accumulation of large quantities of nitrates; (2) the presence of a brown instead of a black color. The soil of these spots always contains large quantities of the sulphates and chlorides of sodium, potassium, magnesium and calcium. A discussion has arisen regarding the source of the nitrates and color of these special alkali spots.

Three theories have been presented regarding the origin of the nitrates in these spots. (1) Hilgard,[3] who first observed the accumulations of nitrates in certain alkali spots in arid soils, attributed them to the more rapid nitrification of the organic matter in the warm arid soils when the moisture factor was removed by the application of irrigation water. (2) Headden[4] believes them to be due to the fixation of atmospheric nitrogen by the non-symbiotic bacteria, notwithstanding the fact that these bacteria have no power to produce nitrates. Sackett,[5] apparently, adopts both the above views. He evidently assumes that the nitrogen is fixed by azotobacter or other non-symbiotic organisms and later nitrified by the nitrifying organisms. (3) Stewart and Greaves,[6] and later Stewart and Peterson,[7] believe the nitrates are due to the leaching and concentrating action of the irrigating water upon the nitrates occurring in the shales and sandstones (or country rock) adjacent to and underneath the affected areas from which the soil has been derived.

It is imperative to obtain a clear conception regarding the origin of these accumulations for two important reasons: (1) Considerable valuable land is being rendered non-productive, due to these enormous accumulations, and methods of reclamation must await proper conception regarding their origin. If the nitrate accumulations are the result of the concentration of the salts preexisting in the country rock proper methods of drainage, adapted to the peculiar soil formation will be effective in reclamation of the soil of the affected area. On the other hand, if the accumulations are due to the abnormal activity of the non-symbiotic bacteria, drainage is not only not effective in the reclamation of these lands but actually detrimental, since it makes more favorable the conditions for such bacterial activity. If the later conception is true, investigations must be undertaken to devise methods for checking the abnormal activity of the non-symbiotic bacteria. (2) Dr. Hopkins says:

> To increase or maintain the nitrogen and organic matter of the soil is the most important practical problem of American agriculture.

If conditions in certain irrigated soils of the arid west are such as to bring about such an abnormal fixation of atmospheric nitrogen as to render the soil non-productive, due to the production of enormous amounts of nitrates, it is important that the conditions governing such fixation may be clearly understood in order that advantage may be taken of this

2 Headden, Colorado Exp. Sta. Bul. 155.

3 Hilgard, "Soils," p. 448.

4 Headden, Colorado Exp. Sta. Bul. 155.

5 Sackett, Colorado Exp. Station Bul. 179.

6 Stewart and Greaves, Utah Exp. Sta. Bul. 114, 1911.

7 Stewart and Peterson, Utah Exp. Sta. Bul. 134, 1914; *Jr. Am. Soc. Agron.*, Vol. 6, 241.

process in other soils and thus solve the most important problem in American agriculture.

These niter spots are characterized by the following conditions: (1) The presence of large quantities of nitrates; (2) the inevitable presence (usually larger quantities) of other soluble salts such as the chlorides and sulphates of sodium, potassium, calcium and magnesium; (3) the absence of appreciable quantities of soluble carbonates; (4) the presence of a dark brown color or stain; (5) the formation of a hard crust on the surface of the soil; (6) underneath the crust there is a layer of dry dust with fine alkali salt crystals which gives an ash-like or mealy condition of the soil; (7) beneath the ash the soil is moist, sticky and glistening. These niter spots usually occur in cultivated soil after it has been irrigated for a few years. But they likewise occur in the non-irrigated and non-arable soils of the mountains wherever moisture conditions are favorable to the concentration of the salts.

Over four hundred samples of the country rock were collected from the original rock adjacent to the soils in the affected areas and these were analyzed for nitrates and other soluble salts. These data form a basis for the theory developed by us. The soils most affected are those derived from the Mancos shales of the cretaceous as well as from the shales and sandstones of the tertiary deposits.

Sufficient evidence has been presented by us to show conclusively that these nitrate accumulations are the direct result of the concentrating and leaching action of the irrigating water upon the nitrates already existing in the original country rock adjacent to and underneath the affected soils. Briefly summarized, our case rests upon the following evidence: (1) Highly productive, irrigated soils rich in organic matter, free from alkali, are also free from niter spots, or nitrate accumulations. (2) Alkali and nitrate-free soils, under similar climatic conditions, irrigated with water from the same river, geographically adjacent, but derived from different geological series, have been cultivated and irrigated for ten times as long as the niter soils, yet are free from nitrate accumulations. (3) The total alkali salts of any given spot fluctuate from year to year; the nitric nitrogen and total salts, as measured by the chlorine content, increase and decrease in quantity in the same general ratio. The same influences must be at work on both. (4) The amount of chlorides and sulphates present are enormous in quantity and are sufficient in themselves to render the soil non-productive. Thus in a characteristic spot a noted increase of nitric nitrogen in four years of 621 pounds was accompanied by an increase of 128 tons of chlorine and 315 tons of total alkali salts. (5) There is no record of "niter spots" free from these other salts; the nitrates and other alkali salts must therefore be associated in some manner. (6) Lipman[8] has shown conclusively that alkali salts not only do not have a stimulating effect on the production of nitrates in alkali soils, but, on the contrary, nitrification is inhibited. (7) The fixation of atmospheric nitrogen in the non-irrigated soils[9] of Utah is much greater than in the niter soils, yet the nitric nitrogen content of the latter is only normal, being less than six parts per million. (8) Niter spots, possessing all the characteristics, occur in the virgin state in the uncultivated and non-arable areas of the near-by hills wherever the water conditions are such as to cause a leaching and concentrating action on the soluble salts, including the nitrates preexisting in the rock itself. (9) There are large quantities of nitrates in a widely disseminated form, occurring in the country rock adjacent to and underneath the affected soils. (10) These nitrate accumulations although not of any commercial economic importance, so far as known, because of their wide distribution, are more than sufficient, being greater in quantity than those of Chili, to account in full for the nitrate accumulations observed in the alkali soils.

This evidence leads us to the inevitable conclusion that the non-symbiotic bacteria are not

8 Lipman, *Central f. Bkt.*, Abt. II., Bd. 33, s. 305.

9 Greaves, *Central f. Bkt.*, Abt. II., Bd. 41, p. 444.

responsible for the production of the nitrates noted in the niter spots of the affected soils of the arid west and their presence there is only incidental and of *no more economic importance than their more abundant occurrence in other normal "niter"-free soils of the arid regions.* The nitrates present in the "niter spots" are the direct result of the leaching and concentrating action of the ground water upon the nitrates preexisting in the country rock adjacent to or underneath the soil of the affected area.

The nature and source of the color present in these spots is of no economic importance whatever except as evidence in support of one or the other of the theories regarding the origin of the nitrates themselves. The azotobacter are in no way concerned in the production of this color. In the normal dry farm soils of Utah the maximum fixation of nitrogen by the non-symbiotic organisms is greater than in the niter soils, yet these soils are free from nitrate accumulation and the color and other characteristics likewise are absent.

and decomposing action (double decomposition) of the nitrates of sodium and potassium upon the old organic matter or humus already occurring in the shale and sandstone is sufficient to account for the production of the color in these "niter spots."

The nitrates of sodium and potassium do have a solvent action on organic matter as already demonstrated.[10] A rich greenhouse soil already abundantly supplied with nitrate was extracted with water for 24 hours as in the official humus determination. A highly colored solution resulted. An aliquot portion on evaporation to dryness and ignition gave a loss of 0.57 per cent. The soil was then extracted with the various soluble salts of sodium, potassium, magnesium and calcium. The variation in intensity of the color was very pronounced with the extract of the different salts. How can this fact be best conveyed to the reader is an important question which arose? The following data were obtained on evaporation and subsequent ignition of an aliquot portion of the extract:

Bases	Sodium				Potassium				Magnesium			Calcium	
Salts	CO_3	SO_4	Cl	NO_3	CO_3	SO_4	Cl	NO_3	SO_4	Cl	NO_3	Cl	NO_3
Per cent. dissolved	5.7	1.19	0.72	0.8	4.2	0.78	0.57	1.4	0.57	0.48	0.49	0.19	0.20

The color is due to the solvent and decomposing action of the nitrates upon the old organic matter or humus in the soil. The source of the old organic matter, like the nitrates, may be found in the adjacent shales which as already pointed out are coal- and oil-bearing. Some of the most important coal deposits of Utah and Colorado are found in these shales and sandstones. As a result the ordinary shale contains more or less organic matter. As an illustration, the analysis of twelve samples of shales from near Grand Junction, Colorado, gave an organic nitrogen content of 1,840 pounds per two million pounds of shale.

The assumption of the hydrolyzing action of sodium nitrate and the subsequent humification of the organic matter of the soil to form the brownish colored organic compounds *is as unnecessary as it is untenable.* The solvent

Notwithstanding the confessedly crude method of conveying a conception of the variation in color extracted by the several salts, considering the results as a whole two important facts are evident: (1) the solvent action upon the organic matter of the salts of sodium and potassium and (2) the repressive action of the salts of magnesium and calcium. The solvent action is very pronounced in the cases of sodium and potassium carbonate and the repressive action is very pronounced in the case of the salts of calcium. How may we interpret these data?

The aqueous extract alone dissolved some colored organic matter due undoubtedly to the fact that the soil itself contained *several hundred parts per million of nitrate.* Likewise,

10 Stewart and Peterson, *Jr. Am. Soc. Agron.*, Vol. 6, p. 247, 1914.

owing to the presence of this nitrate in the soil, the chlorides, sulphates of sodium and potassium exert a solvent action on the organic matter. The potassium nitrate has a decomposition, while the solvent action of the more pronounced solvent action on the organic matter, which is intensified by double carbonates of sodium and potassium are undoubtedly intensified by the hydrolyzation and consequent production of caustic alkali. The salts of calcium exert a repressive action because of the double decomposition and the union of the calcium to formed insoluble calcium salts of the colored organic acids present as already explained. In the presence of old organic material such as occurs in the coal-bearing shale the humifying action of *either the carbonates or other salts* is entirely negligible but it undoubtedly is true that the humifying action upon fresh organic matter of the caustic soda produced by the hydrolyzation of the sodium carbonate is an important factor in the production of the black color of the black alkali spots of alkali soils.

Furthermore, the solvent action of potassium nitrate on old organic matter may be observed in the extraction of peaty soils in the determination of acidity of the soil by the Hopkins method. The potassium nitrate extract of peaty soils in this determination is always colored, due to dissolved organic material. The intensity of the color frequently is so great as to give considerable trouble in the subsequent titration of the extract with an alkali, because the change in color of the indicator can not be observed. The solubility of the old organic matter of peaty soils in potassium nitrate is certainly entirely analogous to the solubility of the old organic matter in the coal-bearing shales and sandstones which constitute the parent material out of which the soils of the "niter" areas are formed.

The color thus can be readily accounted for without the instrumentality of the bacteria, while, moreover, artificial niter spots may be produced in the laboratory on a small scale under conditions which preclude the presence of any bacterial life whatever. Three hundred grams of a greenhouse soil, rich in humus, was placed in small evaporating dishes and the dish filled with a 10-per-cent. solution of sodium nitrate. The solution was then allowed to slowly evaporate by the sun's rays. When all the moisture had evaporated there was produced characteristic niter spots including the color, hard crust and the mealy crystalline condition underneath the crust due to the accumulation of the soluble salts. *These spots were likewise produced when the nitrate was added in the solid form and the moisture added with a saturated solution of mercuric chloride or a 5 per cent. solution of carbolic acid. Control samples of the same soil, in the absence of the nitrate, with or without the antiseptic, failed to produce either the color or other indications of the niter spots.* It is evident, therefore, that the bacteria play no important rôle in either the production of the nitrates or color of the "niter spots" of certain western soils.

In addition to the evidence already published, a detailed paper dealing with the problem as it affects other soils than those already discussed is being prepared and will be published later elsewhere.

ROBERT STEWART
UNIVERSITY OF ILLINOIS
WILLIAM PETERSON
UTAH AGRICULTURAL COLLEGE

MOTTLED LIMESTONES AND THEIR BEARING ON THE ORIGIN OF DOLOMITE[1]

SEVERAL examples of limestone mottled with dolomite have been described during the past few years, but R. C. Wallace was the first to attempt seriously to interpret their meaning. In a very suggestive paper entitled "Pseudobrecciation in Ordovician Limestones in Manitoba"[2] he points out that the dolomite patches in these limestones follow fucoid-like markings suggesting algæ, and concludes that the relationship has resulted from a process of local replacement produced by the magnesia contained in algæ which were imbedded in the

[1] With the permission of the director of the Iowa Geological Survey.

[2] *Jour. Geol.*, Vol. XXI., 1913, pp. 402–421.